

Performing Safety Tests to Comply with the Low Voltage Directive

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Three basic safety tests can help manufacturers ensure that electrical products meet the requirements set forth in the LVD.

The Low Voltage Directive (LVD) does not specify the actual product safety tests that must be performed.

It does, however, state that any electrical product designed for use with a voltage rating between 50 and 1000 V ac and between 75 and 1500 V dc must comply with harmonized standards in order for the products to be marketed in the European Union (EU). This achieves a primary EU goal, which is "to provide a standardized means of allowing commerce between member countries." The directive's provisions require that only electrical equipment that does not jeopardize the safety of people, domestic animals, and property may be placed on the market.

Under the LVD, harmonized safety standards provide a single certification for compliance, which is recognized by all EU members. This article discusses several product safety tests that can help manufacturers meet the requirements of the directive.

Product Safety Testing Requirements

The LVD requires that electrical equipment be designed and constructed to ensure that it is safe when connected to the electric supply system. Equipment must provide a level of protection against electric shock that relies on a combination of insulation and a protective grounding conductor. The equipment is presumed to satisfy this requirement if it is constructed so that it includes either protective grounding or double insulation to provide an equivalent level of safety. Equipment

must be constructed following good engineering practices in relation to safety matters to ensure that it does not cause a safety risk when used in the applications for which it was made. The following items are exempt from the directive:

- Electrical equipment for use in an explosive atmosphere.
- Electrical equipment for radiology and medical purposes.
- Electrical parts for goods and passenger lifts.
- Electric meters.
- Plugs and socket outlets for domestic use.
- Electrical fence controllers.
- Radioelectrical interference equipment.
- Specialized electrical equipment used on ships, aircraft, or railways that complies with the safety provisions drawn up by international bodies in which the member states participate.



An automated system for testing product compliance with LVD requirements. The system performs dielectric withstand, insulation resistance, ground bond, and line leakage tests with a single connection to the product under test.

Each standard provides a series of safety tests with specific test parameters and limits appropriate for the equipment category covered. Three commonly used product safety tests

that check the protective grounding circuits and the insulation within the electrical equipment are the earth ground bond test, the dielectric withstand test, and the line leakage test.

Ground Bond Test

The ground circuit is the second level of protection against electric shock beyond a product's basic insulation. The ground bond test is normally specified to test the protective ground-

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ing circuit within a product. Figure 1 shows a common setup for a ground bond test. An example of the requirements, taken from *The Safety of Household and Similar Electrical Appliances* (EN 60335-1), states:

A current from a source having a no-load voltage not exceeding 12 V (ac or dc) and equal to 1.5 times rated current of the appliance or 25 A, whichever is greater, is passed between the earthing terminal or earthing contact and each accessible metal part in turn. The voltage drop between the earthing terminal of the appliance or the earthing contact of the appliance inlet and the accessible metal part is measured. The resistance is calculated from the current and this voltage drop; the resistance shall not exceed 0.1 Ω . The resistance of the supply cord is not included in the measurement.

The high current is applied to the grounding conductor because most fuses or circuit breakers can carry a 200% overload for several minutes before they open the circuit. The resistance of this circuit must have sufficiently low impedance to limit the voltage to ground and facilitate operation of the circuit protective devices. Performing this test using a source voltage of 12 V or less minimizes operator exposure to hazardous voltages during the test.

The Dielectric Withstand Test

On a new design, the adequacy of the insulation must be tested from an engineering standpoint. It must also be tested from a manufacturing standpoint to ensure that it was not damaged

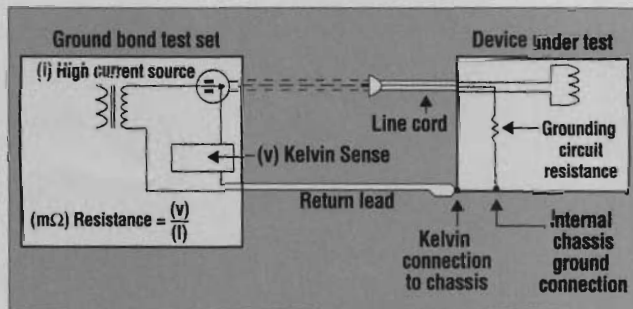


Figure 1. Common setup for a ground bond test.

during the manufacturing process. The insulation within the product provides the primary protection against electric shock. The dielectric withstand test is one product safety test commonly specified to test a product's insulation. A common setup for a dielectric withstand test is illustrated in Figure 2.

Electrical products are subjected daily to high-voltage switching transients. Every time an electric motor is started or stopped it produces a counter electromotive force, which can generate voltage transients that can damage weak insulation. It is assumed that if a product can withstand the potential applied during a hipot (high potential) test, it can withstand these daily switching transients.

The dielectric withstand, or hipot, test stresses the insulation within the product. The leakage current through the insulating materials is measured between what are normally

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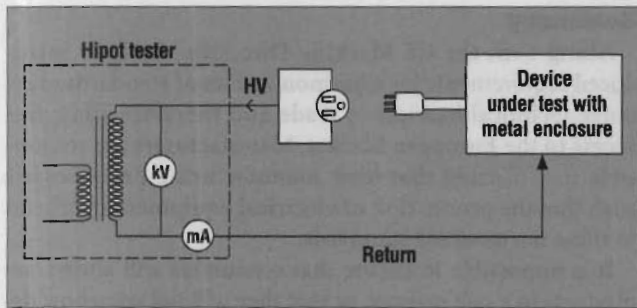


Figure 2. Common setup for a dielectric withstand test.

current-carrying and noncurrent-carrying conductors or ground (earth). Hipot tests may also be performed between primary and secondary circuits within a product to test the isolation between these circuits or between multiple isolated secondary circuits.

The device under test (DUT) is not running during the hipot test. To perform a hipot test, the high-voltage lead is connected to the DUT's hot and neutral conductors, which are shorted together. The DUT's power switch is placed in the on position. The return lead is then connected to any exposed dead metal of the DUT. Directing high voltage to both sides of the line applies equal potential across any components within the circuit under test, stressing only the insulation between the current-carrying conductors and ground.

The test potential may vary depending upon the application of the product. Test potentials of 1500 to 3000 V ac at a frequency of 50 or 60 Hz are common. In some specifications, a dc voltage may be substituted for an ac voltage. The specifications require the dc voltage to be equal to the peak of the prescribed ac test voltage to be used. The voltage is raised gradually from zero to the prescribed test voltage and held for at least 1 second and up to 60 seconds depending upon the test being performed. It is important to note that there cannot be any indication of breakdown during this test. Insulation breakdown is considered to have occurred when the current, which flows as a result of applying the test voltage, rapidly increases uncontrollably, and the insulation can no longer restrict the flow of current. Corona discharges and single momentary flashovers, however, are not regarded as an insulation breakdown condition.

The Line Leakage Test

The line leakage test is also designed to measure the leakage current that flows through the insulation of the product. Figure 3 shows a common setup of a line leakage test. The conditions under which the test are performed, however, differ greatly from the dielectric withstand test. Performed at a much lower voltage, the leakage test monitors leakage currents from accessible parts of the DUT back to the system neutral while the product is operating under both normal and single-fault conditions. Leakage currents are monitored through a measuring device that simulates the impedance of the human body. This measurement provides more accurate data regarding potential shock hazards the DUT could produce. The input voltage applied to the DUT is typically adjusted to 110% of the highest rated line (mains) voltage. Leakage currents are measured under all possible combinations of open and closed

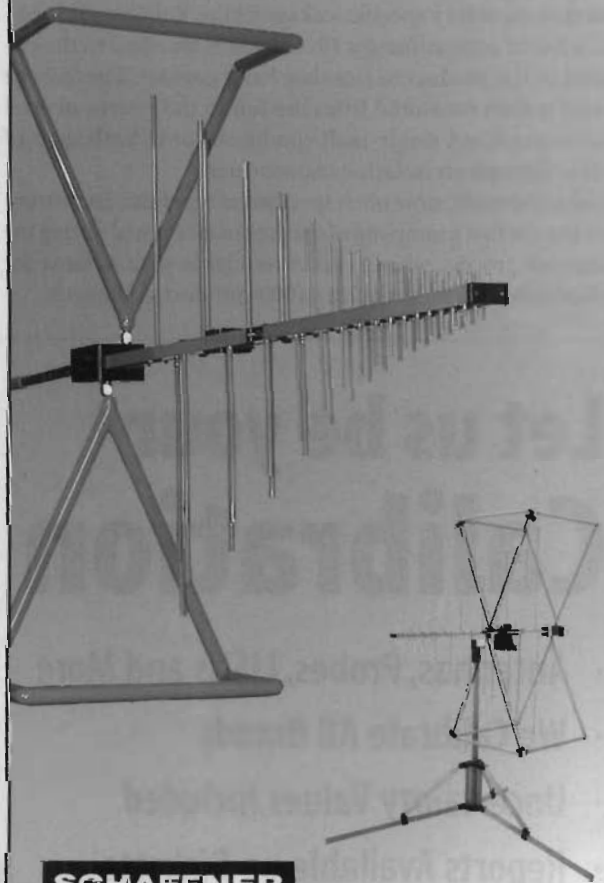
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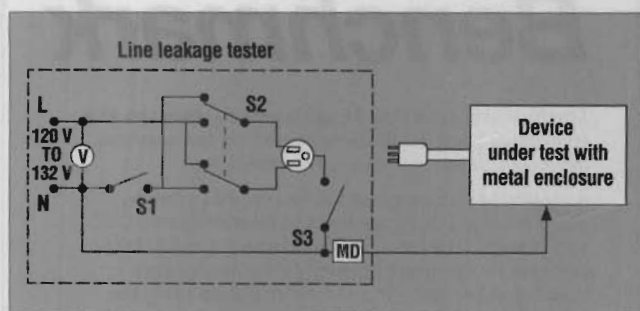


Figure 3. Common setup for a line leakage test.

neutral conductors and normal and reversed polarity. Open and closed grounds are connected to the input of the DUT.

The line leakage test may take the form of a ground leakage test or an enclosure leakage test. These tests are performed on both Class I and Class II products, and unlike the hipot test, these tests have very specific leakage limits. For Class II products, a foil of approximately 10 × 20 cm is attached to the enclosure of the product to simulate hand contact. The leakage current is then measured from the foil to the system neutral under normal and single-fault conditions or to both sides of the line through an isolation transformer.

Leakage tests are more often specified as type tests. Some standards require that a sampling of the products be tested during the production process, whereas other standards, such as those for medical products, may require a 100% production line test.

Summary

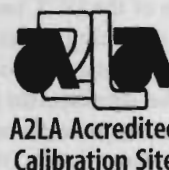
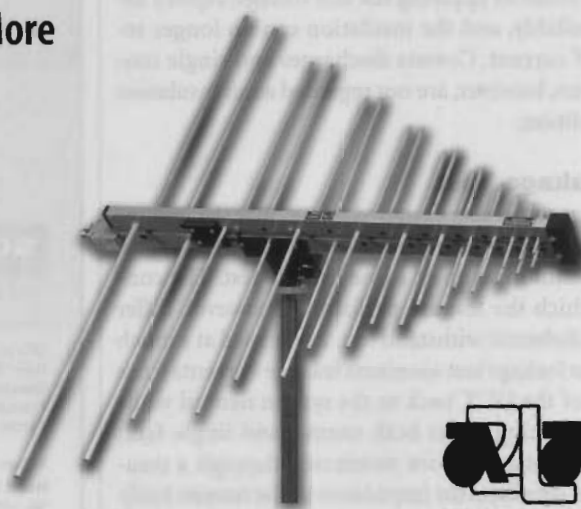
Along with the CE Marking Directive, the LVD introduced requirements for a harmonized set of standards to remove technical barriers to trade and therefore allow free access to the European Market. Manufacturers are responsible for ensuring that their manufacturing processes are such that the production of electrical equipment conforms to these harmonized standards.

It is impossible to ensure that consumers will always use products in a safe manner, or that they will not somehow defeat a product's safety system. For this reason, current product designs incorporate several levels of built-in protection to safeguard users. However, simply incorporating these into an end-product design does not adequately ensure user safety because such safety systems are subject to variations in production that could render them useless. The only way to be certain that a specific product has actually been constructed with the intended safety measures is to test each product before it is shipped. The three basic safety tests described in this article can help manufacturers ensure that products are safe and therefore enable them to meet the requirements of the LVD.

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